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ENTOMOLOGICAL SERIES No. 26.

Insects Attacking the Potato Crop in Connecticut

By W. E. BRITTON.

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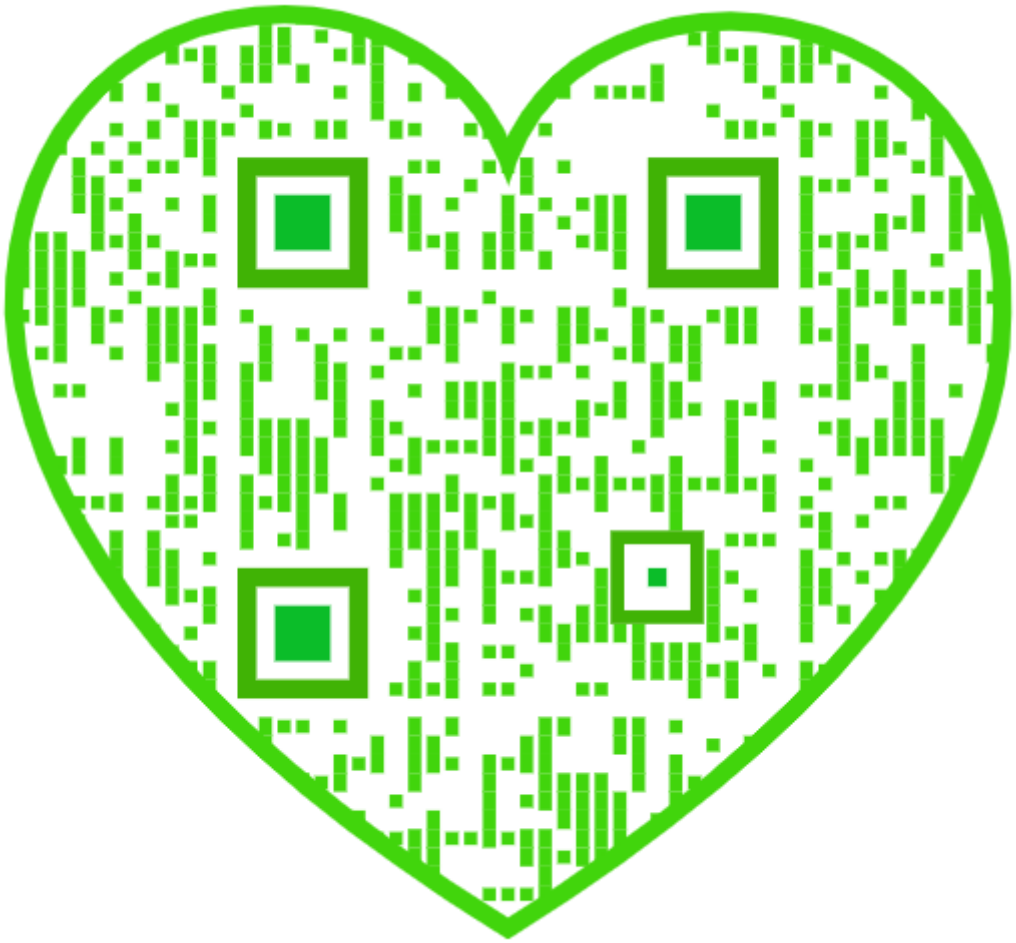

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Insects Attacking the Potato Crop in Connecticut.

By W. E. Britton, *State and Station Entomologist.*

As a rule potatoes in Connecticut are not greatly injured by insects, and remedial measures are seldom required other than to apply lead arsenate to control the Colorado beetle.

In certain seasons, however, other chewing insects will cause some damage. Thus in 1918 the potato flea beetle was abundant throughout the state and perforated the leaves, considerably weakening the plants and injuring the crops. Also the three-lined potato beetle and one of the tortoise beetles were common and of course did some damage.

Cutworms, wireworms, blister beetles, white grubs and the stalk borer all take an occasional toll from the harvest of the farmer. Then in some localities in certain seasons sucking insects, especially aphids, may attack and seriously injure the crop as was the case in 1917 and 1918.

The object of this bulletin is to bring together in a form convenient for ready reference, brief descriptions and illustrations of both the common and the uncommon insect pests of the potato in Connecticut and to recommend control measures, so that the grower may have a guide which may be safely followed. Most of the insects mentioned, will readily be recognized by comparing with the accompanying illustrations (plates XIII-XX) which are essentially a part of this bulletin.

CHEWING INSECTS.

All pests grouped under this heading gnaw away parts of the plant, and those which feed upon the leaves can usually be controlled by arsenical poisons.

Potato Flea Beetle.

Epitrix cucumeris Harris.

This is a small, black, jumping beetle about one-sixteenth of an inch in length. The antennae and legs are yellowish, but the head

thorax and wing-covers are jet black. There is a deep transverse groove at the base of the thorax, and the wing covers are microscopically pitted lengthwise in rows, and bear minute gray hairs. (See figure 1.) Other species injure the potato in the Southern and Western states, but in Connecticut, the attacks observed were due to *E. cucumeris* sometimes called the cucumber flea-beetle, though it more commonly injures the potato. It is usually the first insect to attack the potato vines as soon as they come up. The beetles jump quickly when disturbed and eat small holes from the under side of the leaves, soon perforating them. In many cases the feeding does not extend through the leaf but appears as a blister-like injury on the lower surface. Flea-beetle injury is shown on plate XIII, a.

Figure 1. The cucumber flea beetle *Epitrix cucumeris*, greatly enlarged. (After Chittenden, Bureau of Entomology, U. S. Department of Agriculture.)

The beetles hibernate under rubbish and leaves, and the eggs are laid in May or June. The larvae are slender thread-like white worms, which live, and transform in the ground, feeding upon the roots and tubers. Many tubers from the writer's garden where the flea-beetles were very abundant, had small pin-holes extending inward from the surface sometimes as far as half an inch, where the slender larvae had mined, causing imperfect or "pimply" potatoes. The potato flea-beetle has not been carefully studied in Connecticut but it is generally considered that there are two and perhaps three generations each year.

Control Measures: Flea-beetles may be killed by arsenical poisons, trapped by mechanical devices, or driven away by repellants.

Thoroughly coating both upper and under surfaces of the leaves with a heavy spray of lead arsenate (1 lb. in 5 gallons water) will

usually prevent injury. In some experiments a few years ago, tomato and tobacco plants were dipped in this poison before being set in the field, and these plants were not injured though untreated plants close by were badly eaten.

When abundant as in 1918, the absolute control of this insect is difficult and not wholly successful. Several growers reported that they had sprayed as carefully and as thoroughly as seemed possible, yet there were just as many beetles as ever. Be that as it may the beetles are difficult to control by poisoning, because they jump about and feed but little in one place. In the ordinary spraying operations, there are plenty of places where the leaves are not covered with poison, and in such places the flea-beetles can feed unharmed. For under-spraying it is necessary to use extension rods bent at an angle of about forty-five degrees near the nozzle.

Bordeaux Mixture is often recommended as a remedy for flea-beetles; it is only a repellant, however, and does not kill them. Wherever Bordeaux Mixture is used to prevent blight, this mixture containing lead arsenate can and should be applied to check flea-beetles rather than to prepare a different mixture.

On account of their jumping habits, flea-beetles may be caught in "tanglefoot" or other sticky materials and thus be greatly reduced in numbers. A few years ago Professor C. L. Metcalf of the Ohio State University, devised and used an apparatus which has since been described.* Briefly, his device consisted of a soap box with cover, the front end removed, nearly half of the central part of the bottom and a good-sized notch in the lower side of the rear end cut away. The inside of this box was coated with "tanglefoot" and when it was pushed forward along the row the flea-beetles on jumping when disturbed were caught in the sticky material. Modifications were suggested, and wires were introduced to keep the foliage from contract with the "tanglefoot." The box was mounted on wheels so that one man could manipulate it, and it caught flea-beetles at the rate of over 25,000 per acre, most of them being stuck on the lower ledges of the box. Professor Metcalf suggests the possibility of using trays containing kerosene or a heavier oil in the place of these ledges, because the trays could easily be emptied. It was necessary to stop occasionally and remove the beetles and apply more "tanglefoot."

* Journal of Economic Entomology, Vol. 8, p. 240, 1915.

Possibly some device of this sort may solve the problem of controlling flea-beetles, in seasons when they are unusually abundant, and when the success of spraying is questionable.

Colorado Potato Beetle.

Leptinotarsa (Doryphora) decemlineata Say.

For many years this insect has been regarded as the chief insect enemy of the potato crop, and it more than any other single species is responsible for the development of the use of arsenical poisons—Paris green for many years being the only poison used.

The Colorado beetle is a native of the Rocky Mountain region of the Southwest, where it fed upon the indigenous plants of the

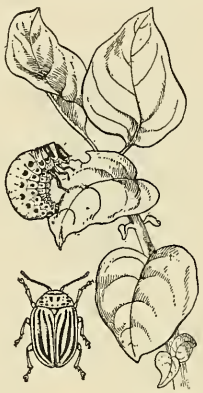


Figure 2. Colorado potato beetle; larva and adult. Natural size.

potato family. As the country gradually became settled, and each pioneer pushed westward a little beyond his neighbor and planted his patch of potatoes, there came a time about 1855 when the frontier of potato growing reached the region where these beetles were native, and they began to feed upon the potato foliage. These potato patches like rungs of a ladder made excellent stepping places in the eastward progress of the beetle. About 1864 it crossed the Mississippi River and in about 1874 it was first recorded along the Atlantic seaboard. At first, hand-gathering was the remedy and it was predicted that farmers must give up growing potatoes. Soon it was found that Paris green would save the vines and kill the insects. Thus for nearly fifty years, potatoes have been grown and the Colorado beetle held in check by the use of arsenical poisons.

The eggs are bright yellow and are laid on the under side of the leaves in clusters of about a dozen as shown on plate XIV, b, and hatch in about a week. One female lay from 500 to 1,000 eggs. The adult is a yellow beetle about three-eighths of an inch long, with five black stripes running lengthwise on each wing-cover and a series of black spots on the thorax. The larva is a stout, fleshy grub reddish in color with black head and marked with black spots as shown on plate XIV, a. Both adult and larvae are shown in figure 2.

The adults appear in early spring and are ready to feed upon the first potato leaves to show above ground. The larvae require about three weeks to reach maturity when they go into the ground to pupate. Probably there are two and sometimes three generations each year, the winter being passed in the ground as pupae or as adults.

Perhaps the most important insect parasites of the Colorado potato beetle in Connecticut are the two-winged flies belonging to the family Tachinidae. Two species have been reared from larvae and identified as *Doryphorophaga doryphorae* Riley, and *D. aberrans* Town.

Several predaceous insects feed upon the eggs or larvae of the Colorado beetle; among these are the lady beetles which devour the eggs and small larvae, the ground beetles especially *Lebia grandis* Hentz, and the soldier bugs, particularly the spined soldier bug, *Podisus maculiventrus* Say.

Turkeys, crows, and red-breasted grossbeaks feed somewhat on the Colorado potato beetle.

Control Measures: Spraying the foliage with an arsenical poison is the most satisfactory means of control in the field. For nearly fifty years Paris green was used for this purpose, but it has now been superseded nearly everywhere by lead arsenate.

Arsenate of lead is safer than Paris green and adheres better to the foliage. It contains less arsenic and therefore requires more per barrel to kill the beetles. It is made in both the dry or powdered form, and in form of paste containing 50 per cent. water. Usually it is applied as follows:

Lead arsenate (paste)	3 lbs.
Water	50 gals.

Instead of the paste, the dry form may be substituted using half as much by weight or one and one-half pounds. It may also be sifted or blown upon the wet plants without being mixed with lime or any other diluent. This poison may also be added to Bordeaux Mixture or nicotine solution without injury to the foliage providing soap is omitted.

Paris green is a powerful poison in the form of a dry powder. It may be mixed at the rate of 1 lb. in 100 lbs. with land plaster or air-slaked lime and dusted or blown upon the wet plants or applied as a spray using from one-third to one-half pound in 50 gallons of water. As Paris green contains some free arsenic in acid form there is always danger of burning the leaves with it unless lime is added to take care of the free acid. A good formula for making the spray is as follows:

Paris green	½ lb.
Quick lime	2 lbs.
Water	50 gals.

The lime should be slaked before adding to the mixture. The poison may be used in combination with Bordeaux Mixture without additional lime as the Bordeaux Mixture contains an excess of lime. Though Paris green may be used successfully, as it has been used for many years, it will wash off with the first heavy rain unless Bordeaux Mixture or some other good adhering agent is present.

During the past few years, several arsenical poisons have been tested in the field, and some even have been placed upon the market. Arsenite of zinc is one of these tested in Connecticut a few years ago. Arsenate of lime is a more recent acquisition, which is made in dry or powder form. It is very fine and light, and remains well in suspension. It was considerably cheaper in 1918 than lead arsenate. When used there should be an excess of lime present to prevent burning. A spray mixture containing Bordeaux already has lime in excess, so that additional lime is unnecessary. In the small home garden, the beetles may be gathered by hand and destroyed, especially where on account of children or domestic animals it seems undesirable to use poison.

As a rule the adult beetles emerge from the ground early in May and attack some of the potatoes as soon as the plants appear. Later the larvae also appear on certain plants here and there scattered over the field. At this time of the season lead arsenate is about the

only spray material required. The plants are small and if a power sprayer is used most of the material will strike the ground and consequently be wasted.

Probably the most economical treatment is to send a man through the field with a compressed air sprayer (or with duster or powder gun if the dry poison is used) and poison only those plants where the insects are feeding. Later when the larvae are more abundant and most of the plants are being injured, all should be sprayed.

As the blight does not start until about July 1st, Bordeaux Mixture may be withheld until the latter part of June: then the foliage should be kept covered as long as the plants are making growth and lead arsenate should be added to the Bordeaux as long as there is danger from leaf-eating insects.

The traction power sprayers often used in potato fields are generally unsatisfactory (1) because they do not apply enough liquid (2) because they treat all plants alike whether infested or not. If an outfit is used which does not depend upon traction for power, it is possible to stop and spray for a few minutes, in order to thoroughly coat the plants in certain sections of the field where the infestation is heaviest.

A gasoline engine will furnish power for larger operations, and a hand pump like that shown on plate XIII, b, will answer nicely for small fields.

Three-Lined Potato Beetle.

Lema trilineata Oliv.

This beetle is yellow with three black stripes running lengthwise and resembles the striped cucumber beetle but is larger, and the thorax is constricted and marked with two black dots. The eggs are yellow and resemble those of the Colorado beetle, but are smaller and are more apt to be attached to the midrib of the leaf instead of promiscuously in clusters. They are shown on plate XV, a. Both kinds are laid on the under side one end of each egg being attached to the leaf.

The larvae usually line up in a row side by side on the under surface and devour the leaf working from the tip toward the base and leaving the larger veins. The larvae are buff or tan in color, but are partly covered by their own black or brown excrement, giving them a very disgusting appearance. Eggs, adults and larvae are shown on plate XV.

There are two generations each year, the larvae appearing in June and in August, and the winter is passed in the pupa stage. This insect was more abundant in 1918 than the writer has ever seen it in Connecticut. The same arsenical poison that is used against the Colorado beetle, will control the three-lined beetle.

Tortoise Beetles.

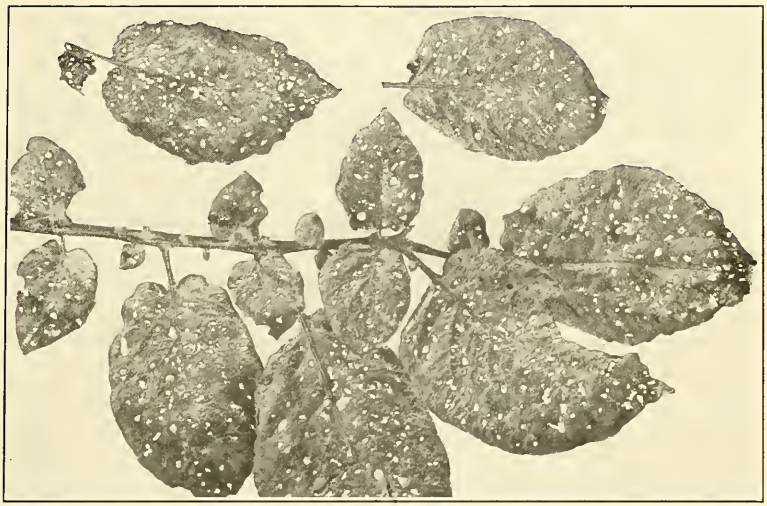
Occasionally potatoes are attacked by small hemispherical beetles having a rather conspicuous marginal flange, known as tortoise beetles. They feed upon the wild morning glory or bindweed and also upon the sweet potato. There are at least three species in Connecticut belonging to the genus *Coptocycla*. *Coptocycla bicolor* is of a beautiful irridescent gold color in life often with inconspicuous black spots. It is sometimes called the "gold bug" or "gold beetle." The other two species *C. clavata* Fabr and *C. guttata* Oliv are both brown on the back with the marginal flange translucent. In *C. guttata* the dark portion is more or less translucent spotted. *C. clavata* is larger with the brown area very rough. This species is shown on plate XVI, a, and was quite prevalent in Connecticut in 1918, being observed in New Haven and Mount Carmel and was received from Clinton, Guilford, Meriden, Monroe, Plainville, and Shelton.

The eggs are laid singly on the veins or stems of the leaves, each egg being covered with a small mass of black excrement. The larvae are dull green, oval, flattened, with lateral projections or spines, and feed upon the under surface of the leaves. They carry their excrement on the caudal spines. There is only one generation each season and the winter is passed in the adult stage, the beetles hiding in crevices and appearing on the potato plants during the month of May.

Though this beetle feeds upon the potato leaves, it probably does not cause very great damage, and may readily be controlled by the arsenical poisons.

The Blister Beetles.

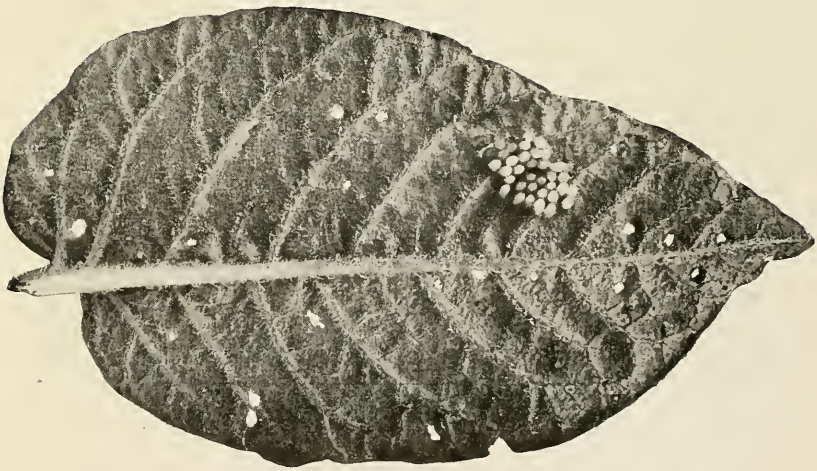
There are several species of blister beetles which may be found feeding upon the potato in Connecticut. These are about half an inch long, less than half as broad, and with soft wing covers. They fed upon potatoes long before the advent of the Colorado beetle and are some times called "old-fashioned potato beetles." Their attacks



a. Potato leaves injured by Potato Flea Beetle, considerably reduced.

b. A good hand-power spray outfit for a potato field of two or three acres or less.

a. Larvae nearly full grown feeding upon leaves. Natural size.



b. Eggs, twice natural size.

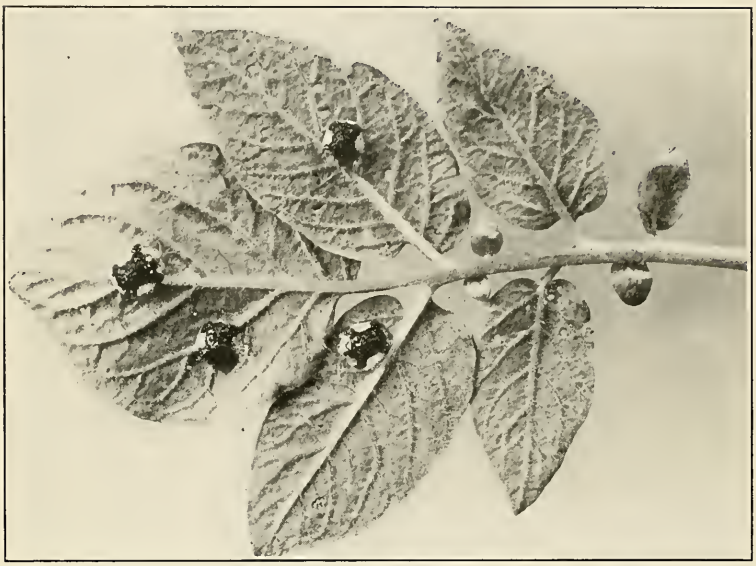
COLORADO POTATO BEETLE.

a. Larvae feeding upon leaf, natural size.

b. Cluster of eggs, natural size.

c. Adults on leaf, natural size.

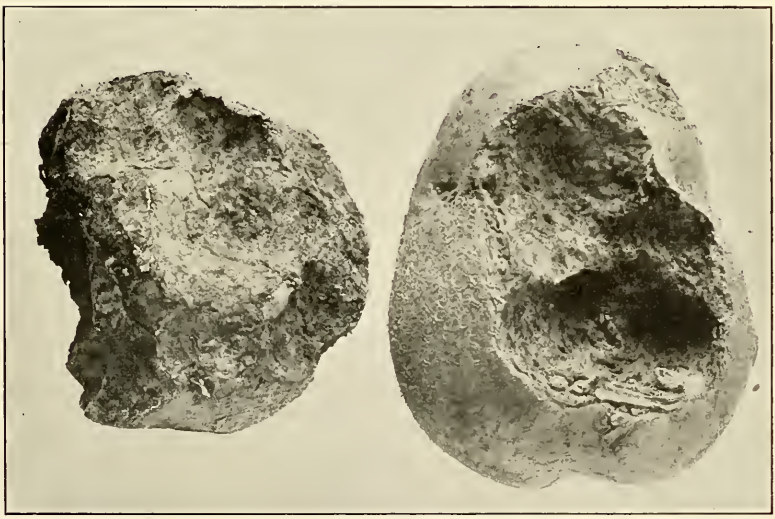
THREE-LINED POTATO BEETLE.



a. Clavate Tortoise Beetle, adults on leaf, natural size.

b. Margined Blister Beetle, adults feeding on leaves, natural size.

a. Potato tubers injured by wireworms.



b. Potatoes eaten by white grubs.

PLATE XVIII.

a. Adult of Stalk Borer, natural size.

b. Immature Stalk Borer in corn, natural size.

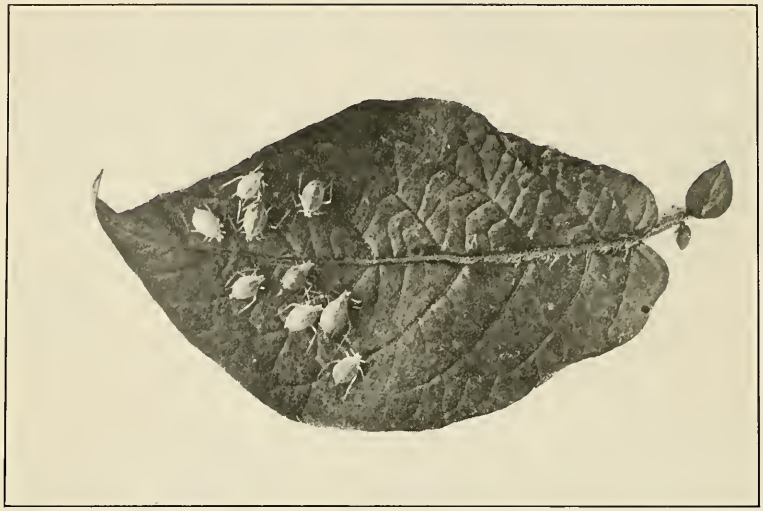
c. Potato Shoot infested with Potato Aphid, natural size.

a. Infested blossom stems, natural size.

b. Aphids on the under side of the leaves, natural size.

POTATO APHID.

PLATE XX.



a. Parasitized aphids on upper side of leaf, natural size.

b. Four-Lined Leaf-Bug and its injury to potatoes. Leaves reduced. Bug about natural size.

are by no means confined to the potato but may include nearly any of the garden vegetables or flowers.

The principal species are the black blister beetle *Epicauta pennsylvanica* Degeer, the margined blister beetle *E. marginata* Fabr., the striped blister beetle *E. vittata* Fabr. and the ash gray blister beetle *Macrobasis unicolor* Kby., all of which occur in great numbers in certain seasons, and all of which occasionally feed upon potatoes. These beetles are common on flowers of golden rod in late summer. The margined blister beetle is shown on plate XVI, b.

The larvae of blister beetles do not feed upon potato foliage like the adults but as they devour the eggs of the grasshopper they must be regarded as beneficial.

Wherever blister beetles are injuring potato plants they may be controlled like any other leaf-eating beetle—by an application of lead arsenate.

The Stalk Borer.

Papaipema nitela Guen., and other species.

Potato stalks are often noticed which have been tunnelled up and down inside, and a dirty white larva striped lengthwise with brown and a darker saddle about one-third of its length from the head is found in the burrow. This is commonly known as the stalk borer and is supposed to be *Papaipema nitela* Guen., but there are many species, and several new ones have been described during the past few years by Mr. Henry Bird of Rye, N. Y.

Some of these insects are restricted in their food, a species being found only in one kind of host plant. But not so with *P. nitela,* which attacks many different kinds of plants, including most of the common vegetables and field crops, and many of the flowers and weeds. In fact it may tunnel in almost any herbaceous stem, especially those of larger size. It is often a serious pest of tomatoes, potatoes, corn, dahlias, lilies, etc. Corn was much injured by it in Connecticut in 1918. The writer has often found it in ragweed and during 1918, found a larva boring in a young melon plant close to the ground.

There is only one generation each year, the winter being passed as a pupa in the soil. The adult is a purplish-gray moth having a wing-spread of about one and one-fourth inches. A common form, var. *nebris,* has the fore wings marked with white spots as shown on plate XVIII, a. The larva is about one and one-half inches long

when fully grown, and has the appearance shown on plate XVIII, b. No control measures can be recommended other than destroying the infested stalks when noticed.

Cutworms.

Like any other vegetables, potato plants are often attacked by cutworms and the stems eaten off near the ground. Cutworms are the larvae of noctuid moths, and there are several species, three or four perhaps being responsible for most of the injury. A common species is shown in figure 3. There is one generation each year, the moths emerging and the eggs being laid the latter part of summer. The cutworms become partially grown before winter then go deep into the soil to remain during the cold weather. Their native food consists of the weeds and grasses. In the spring when

Figure 3. Black cutworm *Agrotis ypsilon*. (After Howard, Bureau of Entomology, U. S. Department of Agriculture.)

warm weather comes they appear to be hungry after their long fast, and cannot resist attacking the tender vegetable plants.

In large fields where cutworms are destructive a poisoned and sweetened mash made of bran should be employed. The following formula will serve:

Wheat Bran	5 lbs.
Paris green or white arsenic	5 ozs.
Lemon or orange	1 fruit.
Molasses	1 pint.
Water	7 pints.

Mix the dry poison and bran together. Squeeze the juice from the lemon or orange into the water, and then cut the pulp and peel into fine pieces and add to the water: then add molasses and stir. Mix this syrup thoroughly with the poisoned bran. This will make a rather dry mash, which may be scattered thinly over the field at

the time when the first injury is noticed or, if tobacco or tomatoes, a few days before the plants are set. If applied just before dark, the cutworms will have a chance to eat it before it dries, the citrus juice and molasses attracting them.

If it is feared that birds or poultry will partake of the poison, a spoonful may be placed in a hole, here and there and covered with a stone, or a bit of board.

Late fall plowing uncovers many cutworms, thus exposing them to birds and other natural enemies. Extremely thorough harrowing will kill many of them.

If one has only a few plants, these may be protected by wrapping the stems with paper or cardboard.

Wireworms.

Wireworms are the larvae of "click" or "snap" beetles and belong to the family Elateridae. There are several species which injure cultivated crops, most of them belonging to the genera *Agriotes, Melanotus* and *Drasterius*. They are small, hard, cylindrical larvae, and are usually tan or reddish-brown in color. They are usually more troublesome in sod land and first bore into the seed tubers, then tunnel into the main stem of the plant just below the surface of the ground, occasionally causing considerable damage in early summer. Later in the season they tunnel into the tubers, causing the injury shown on plate XVII, a, particularly in the "scabbed" areas greatly injuring the appearance and market value as well as the real value of the tubers for food. From three to five years are required for wireworms to go through their complete life cycle, and all stages except the adult are spent in the soil. They are usually more abundant and therefore more troublesome in sod land than in old ground. Crop rotation should be practiced. Where possible plow sod land in the fall and harrow at frequent intervals before the ground freezes. Where wireworms are abundant potatoes should be dug as soon as ripe as they will be seriously injured if allowed to remain for several weeks in the ground.

White Grubs.

Like wireworms and cutworms, white grubs feed naturally in grass lands and are responsible for much injury to crops,—especially in certain seasons and when planted on sod land. White grubs are the larvae of the May or June beetles belonging to the

genus *Lachnosterna* of the family Scarabacidae. There are some fifteen species occurring in Connecticut, but as *Lachnosterna fusca* Froh., *L. crenulata* Forst., *L. hirticula* Knoch., *L. nova* Smith and *L. fraterna* Harris, are some of the commoner kinds, it is to be supposed that they are responsible for the damage.

The life cycle of our chief species requires three years for its completion. The eggs are laid in the soil at a depth of from one to eight inches late in May or early in June, and are white and about one-tenth of an inch long. The young grubs feed on decaying vegetation but early eat the roots of living plants. They do their greatest damage in the second year of their larval existence, but may be destructive to early plantations in the spring of their third season.

Figure 4. White grub. Natural size.

Figure 5. June beetle, adult of white grub. Natural size.

Certain seasons are remarkable for the widespread damage caused by white grubs. Thus there was much injury in Connecticut in 1915, and warnings were isuued to the effect that grubs might be expected in 1918. As a matter of fact, white grubs were reported as doing damage in a few localities in 1918, but it was not as serious as in 1915.

Much of the injury is done to grass land, but when infested grass land is plowed and planted to potatoes, the grubs will often cause serious injury to the crop by eating off the roots of the plants, and also eating into the tubers.

A white grub is shown, natural size, in figure 4, the adult beetle in figure 5, and an injured potato on plate XVII, b.

There are several parasites of white grubs, including wasps of the genera *Tiphia* and *Elis,* and the two-winged flies *Pyrgota undata* Wied., *P. valida* Harr, *Promachus fitchii* O. S. and P. *vertebratus* Say. All except the last occur in Connecticut.

Of the many vertebrates destroying white grubs and their adults, the larger birds, farm fowls, and skunks are probably the most important.

Control Measures: Crop rotation is one of the methods of forestalling serious injury from white grubs. Fall plowing of infested land before October 10, will expose many of the grubs where they will be eaten by birds. If poultry or swine can be turned upon the plowed field a much larger proportion of the grubs will be destroyed. This land should be disked and harrowed very thoroughly before planting.

If potatoes follow clover or corn in a white grub year they will not be greatly damaged.

As has already been advised in relation to wireworms, if grubs are abundant or troublesome, the potato crop should be dug as soon as the tubers are mature.

SUCKING INSECTS.

Sucking insects do not tear away, masticate and devour any portion of the plant, but suck out the plant juices, and thus obtain their nourishment in liquid form. Each insect, therefore is fitted with a sucking tube known as rostrum or proboscis, which it thrusts into leaf or stem and through it sucks out the sap.

Insects of this kind cannot be controlled with arsenical poisons, but something must be applied that will kill them by contact, and nicotine solution and oil and soap emulsions are used for this purpose.

The Potato Aphid.

Macrosiphum solanifolii Ashm.

Both in 1917 and 1918, this aphid caused considerable damage in the potato fields in the southern half of the state, and an account of the former infestation was published in the Report of this Station for 1917, page 290. This aphid is often called the pink and green potato aphid because some individuals are pink or reddish and others are green. It is shown in figure 6, and occurs commonly on solanaceous plants as well as on rose, beet, squash, lettuce, corn, milkweed, bitter-sweet and many weeds and other plants around the field. During the past 18 years it has been collected a dozen times on several different plants in various parts of the State. The earliest record is June 18, 1901, New Haven, on *Clematis crispa*. Some of

these records were from potato and tobacco, but the insect did not cause any severe or wide-spread injury to the potato crop until 1917, when it damaged fields in every county in the State, and was reported from many localities in New Haven and Hartford Counties. The vines soon died and the crop was light on account of this injury. In 1918, the writer had a better chance to observe the work of this aphid. It was first seen at the Station farm at Mt. Carmel on June 11, a very few individuals (probably stem mothers) here and there on the under sides of the leaves in the northeast corner of

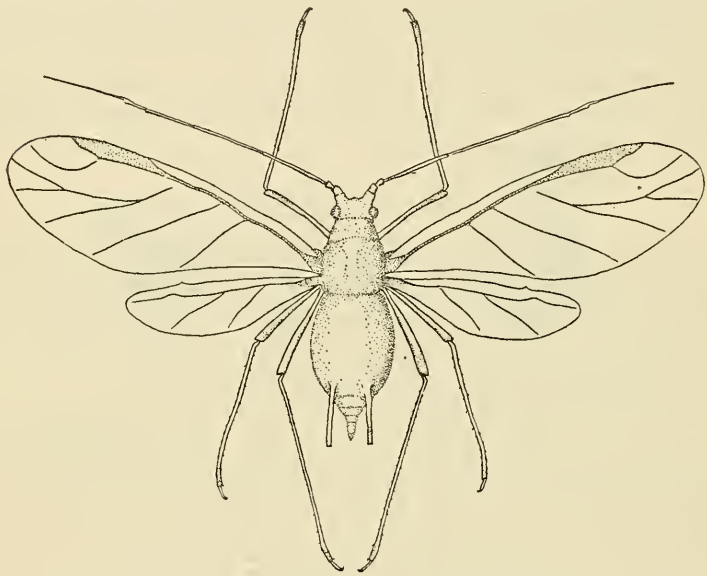


Figure 6. The potato aphid, winged female, summer form. Greatly enlarged.

the field. On June 14, they were more abundant, both pink and green wingless forms being present, and some had begun to produce young.

On June 15, Mr. G. M. Codding observed that potato fields in Greenwich were infested.

On June 20, at the Station farm the aphids did not seem to be any more abundant than on June 14, but a week later (June 27) they had apparently increased, and most of them were on the blossom stems as shown on plate XIX, a. A few occurred underneath

the new leaves at the top of the plants. It seemed advisable to spray, and tests were first made with a number of promising materials which were thought might take the place of soap without the attending danger in the presence of lead arsenate. The field was sprayed however, July 2nd and 3rd with nicotine solution added to Bordeaux Mixture and lead arsenate, using one pint of Black Leaf No. 40 in a barrel (50 gallons) of the mixture. The treatment was not very successful, as the slight wax secretion repelled the spray which rolled off in drops leaving many of the aphids unharmed. Of course a large proportion of them were killed. In three weeks aphids again became so abundant that the field was sprayed again on July 22 and the few days following. By this time many of the topmost leaves were curled and the aphids were very abundant. Nicotine solution had been in great demand, and many retail dealers had sold out. A fresh supply could not be obtained from the factory soon enough to save the crop. Consequently we demonstrated that kerosene emulsion would answer the purpose, at less expense, and the materials could be purchased in any grocery or general country store. The following quantities and materials were used:

FORMULA.

Laundry soap (about 30 oz.)	3 cakes.
Kerosene	4 gals.
Water	2 "

After churning, dilute eight times to make one barrel (50 gals.)

The soap was cut in thin slices and dissolved in hot water over a fire. It was then removed from the fire and added to the kerosene, and the whole churned violently for a few minutes by passing through a bucket pump with a small hose directed into the same container. This made a uniform, creamy mass, from which the oil did not separate on standing. It was applied with strong pressure, through a fine nozzle and a rod bent at an angle of about 45 degrees near the nozzle by means of which it was possible to direct the spray against the under surface of the leaves.

All the aphids hit by the spray were killed without injury to the plants. They disappeared soon after and no further treatment was necessary.

The more common lady beetles, certain syrphid flies and lacewings feed upon the aphids, and many aphids were parasitized by

a small four-winged parasitic fly, *Aphidius rosae* Halliday, as shown on plate XX, a.

This aphid may be controlled by spraying as above indicated, but in some cases it is practically impossible to spray the under side of the leaves. Brushing the vines just before cultivating will destroy a large proportion of them. A driving rain or heavy down pour is very effective in destroying these aphids at the time of their maximum abundance. The aphids are shown on the blossom stems and on the leaves on plate XIX, also parasitized ones on plate XX, a, and the spraying operations on plate XIII, b.

The Four-Lined Leaf-Bug.

Poecilocapsus lineatus Fabr.

This insect is generally regarded as an occasional pest of small fruits but sometimes also injures garden vegetables and field crops. In 1918, the writer observed several instances of severe injury to certain plants usually near the margin of the field, and close to a woodland or weedy uncultivated field. Injured leaves are shown on plate XX, b.

The four-lined leaf-bug lays its eggs in the soft tender stems of currant and doubtless other plants about the first of July. These eggs are long and slender, somewhat curved, and are crowded together in clusters of six or eight and are pushed end-wise into the soft pith, the outer ends showing as a patch of white.

These eggs hatch the following spring, and about the middle of May the young bugs first appear on the top-most and tenderest leaves. They suck out the green pulp from the under side, leaving roundish semi-transparent spots, which often coalesce. As the insect increases in size it sucks out the pulp from larger areas, and the leaf finally turns brown, dries up and dies. This injury is characteristic, but the insects causing it hide away beneath the leaves and are seldom noticed unless one is hunting for them.

The nymphs at first are bright red marked with black spots but soon change to bright orange-yellow. They pass through five stages in about three weeks, and when mature are winged, nearly one-third of an inch long, bright greenish-yellow, with four black stripes running lengthwise on thorax and wing-covers as shown on plate XX, b.

Probably the best control measure is to spray thoroughly the under side of the top leaves with nicotine solution, two teaspoonfuls in one gallon of water, with one-inch cube of soap dissolved and added, or if a quantity is needed, one pint of nicotine solution and two cakes of laundry soap in 50 gallons of water.

Summary.

The potato crop in Connecticut is injured by a number of chewing insects, the most important being the Colorado Potato Beetle and the Potato Flea Beetle. The Three-Lined Potato Beetle, Tortoise Beetles, Blister Beetles, the Stalk Borer, cutworms, wireworms and white grubs all cause occasional damage. All but the last four may be controlled by spraying with lead arsenate. Cutworms may be destroyed by the use of a poisoned and sweetened bran mash scattered about the field. Against wireworms and white grubs cultural practices are the only remedies.

The principal sucking insect attacking potatoes in Connecticut is the Potato Aphid which can be killed by spraying with nicotine solution and soap, or with kerosene emulsion. The Four-Lined Leaf Bug causes occasional damage and may be controlled by the same sprays as are used against the Potato Aphid.

Information regarding each of these pests and the measures necessary to control them may be found in the foregoing pages, and most of them are shown on plates XIII-XX.